

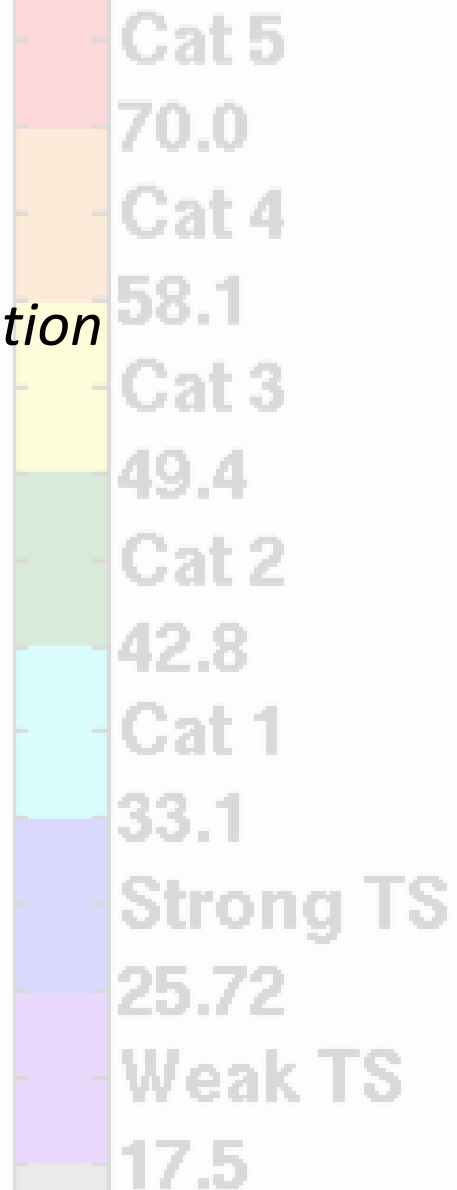
# Hurricane Imaging Radiometer (HIRAD)

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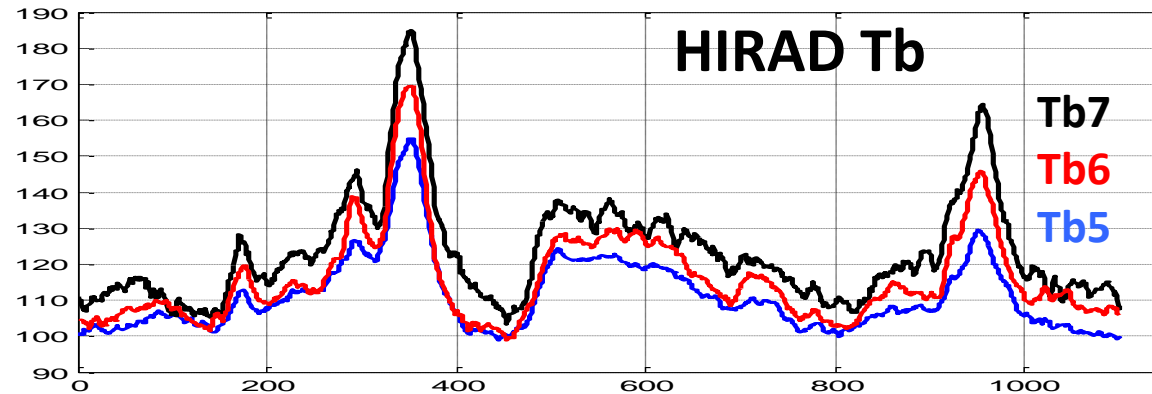
C-band (4, 5, 6, 6.6 GHz)  
radiometer

Retrieval concept similar to  
the operational Stepped  
Frequency Microwave  
Radiometer (SFMR)

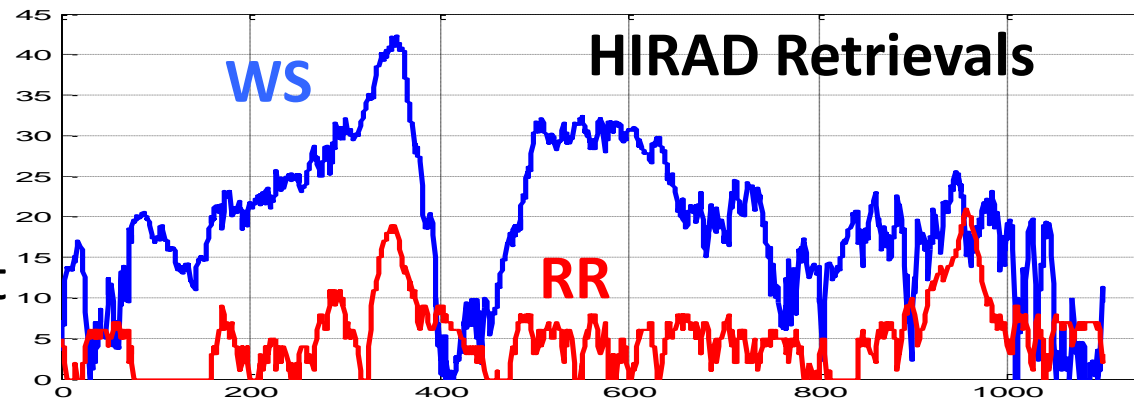
**Retrieve Wind Speed and  
Rain Rate over ocean, *but  
over a wide swath***

C-band frequencies have  
varying sensitivity to rain but  
~equal sensitivity to wind  
speed (emission from foam  
on wind-roughened ocean  
surface)

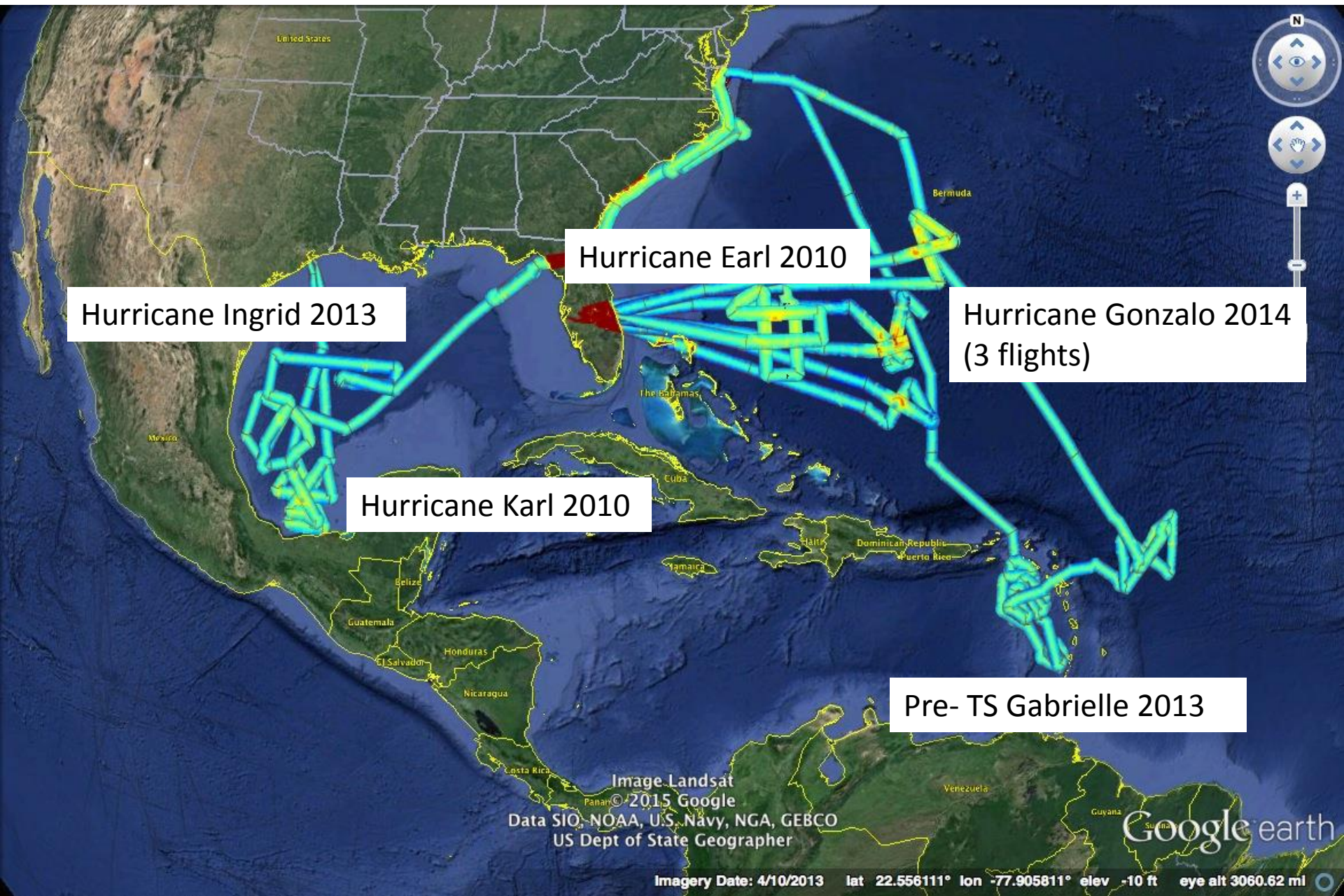
# HIRAD Background



*Hurricane Karl (2010) example*

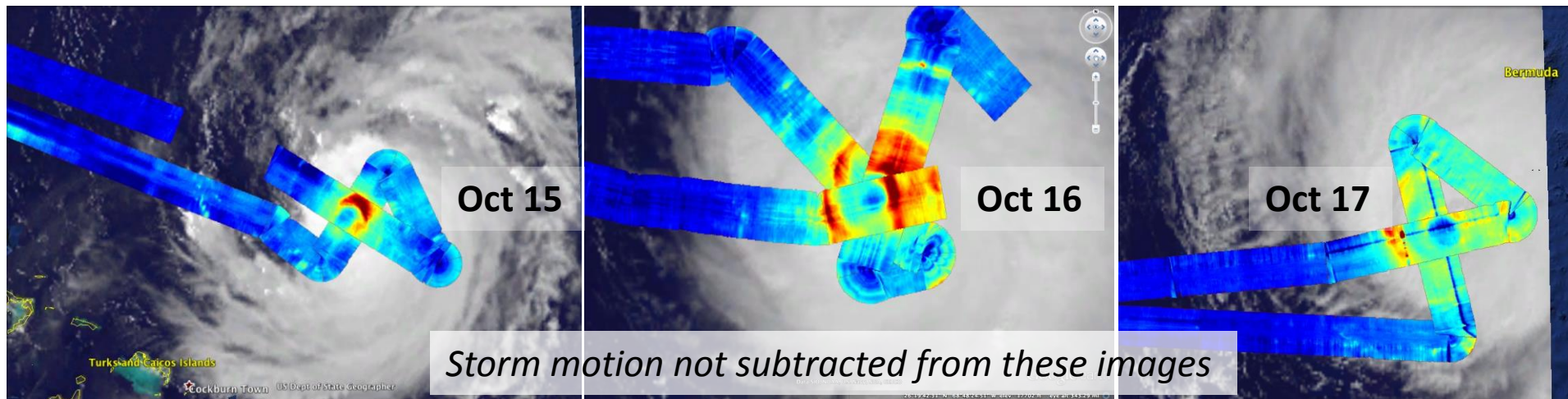


# HIRAD Science Flights





# Hurricane Gonzalo (2014)

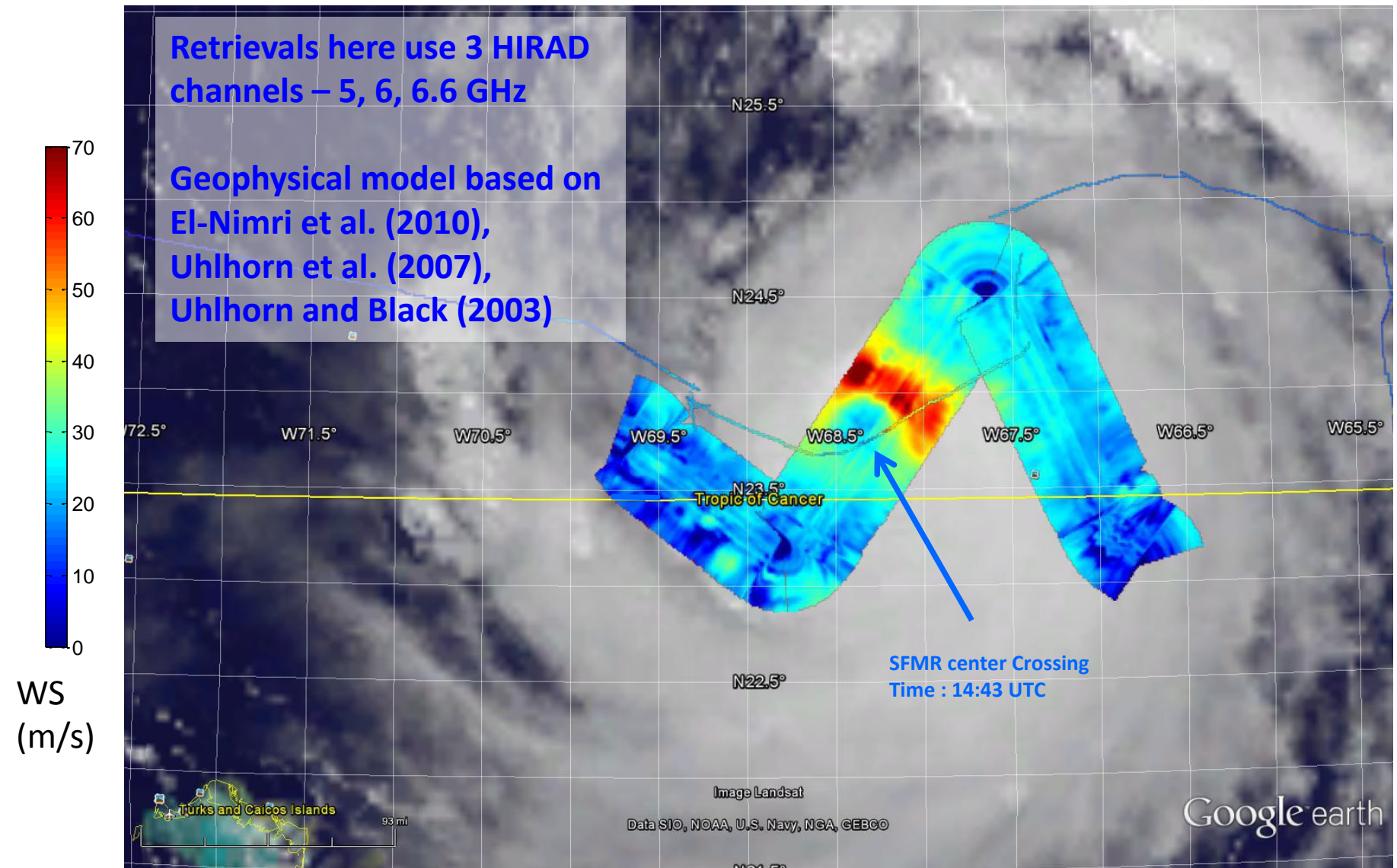


Flown on NASA WB-57 based out of Houston, forward-deployed to Tampa

Cooperation between NASA HS3 program and ONR TCI program

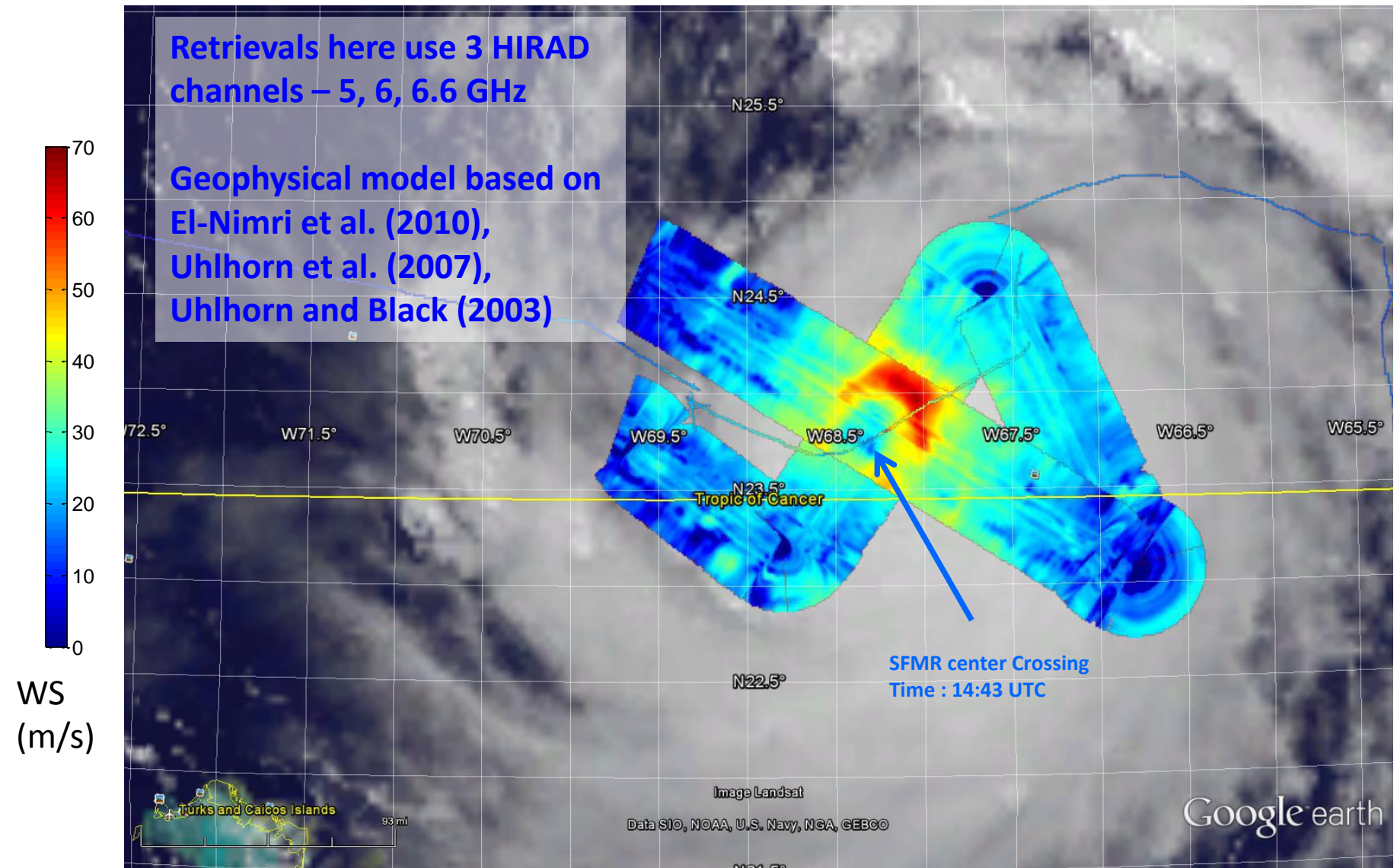
Instruments were integrated onto Global Hawk AV-1 in July for HS3, but AV-1 was unable to perform missions. WB-57 was available for hurricane flights because of the ONR program, so HIRAD and HIWRAP were moved from Global Hawk to WB-57. Kudos to all who made this switch possible!

# First Storm Center Crossing: 20:34 UTC



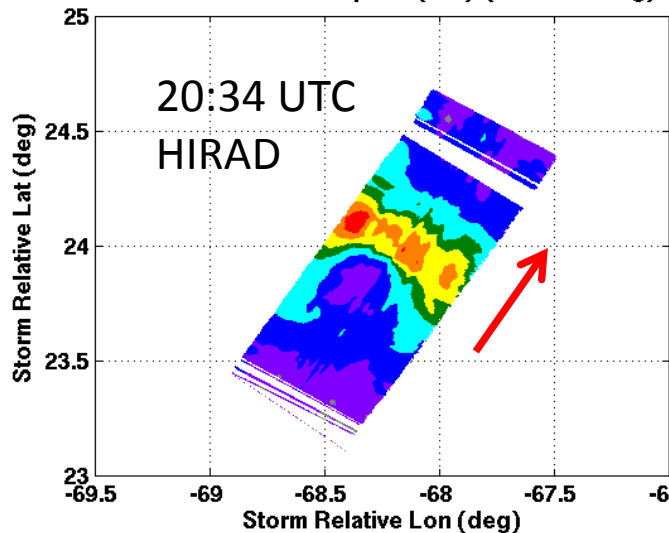


# Second Storm Center Crossing: 21:12 UTC



# Wind Retrievals – Oct 15 Gonzalo

LOS# 1 HIRAD Wind Speed (m/s), (Roll  $< \pm 1$  deg)



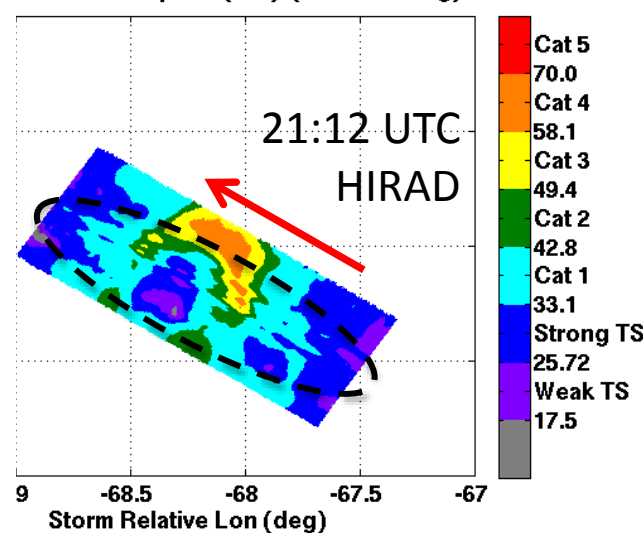
HIRAD has biases at some incidence angles, seen as along-track striping.

Also tends to be high-biased along left edge.

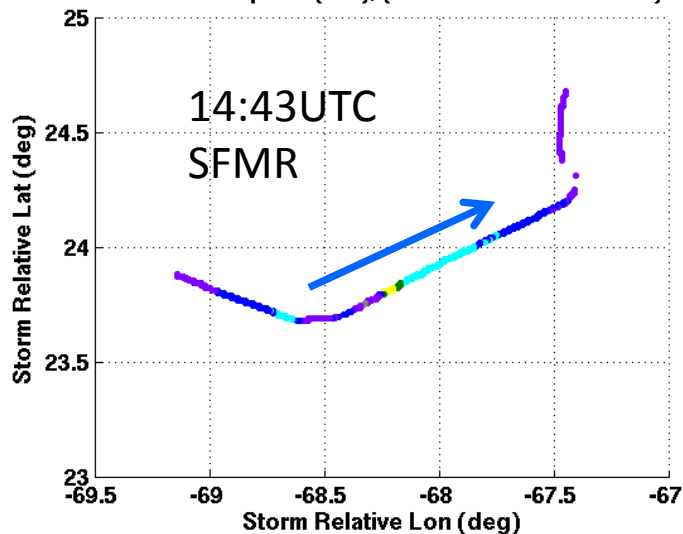
Work in progress

Retrievals here use 3 HIRAD channels – 5, 6, 6.6 GHz

HIRAD Wind Speed (m/s), (Roll  $< \pm 1$  deg)

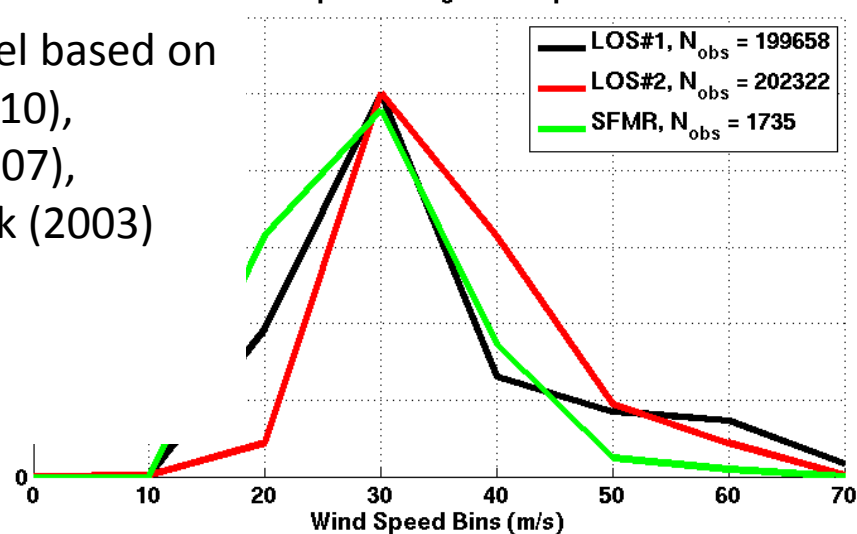


SFMR Wind Speed (m/s), (Over The Storm Portion)

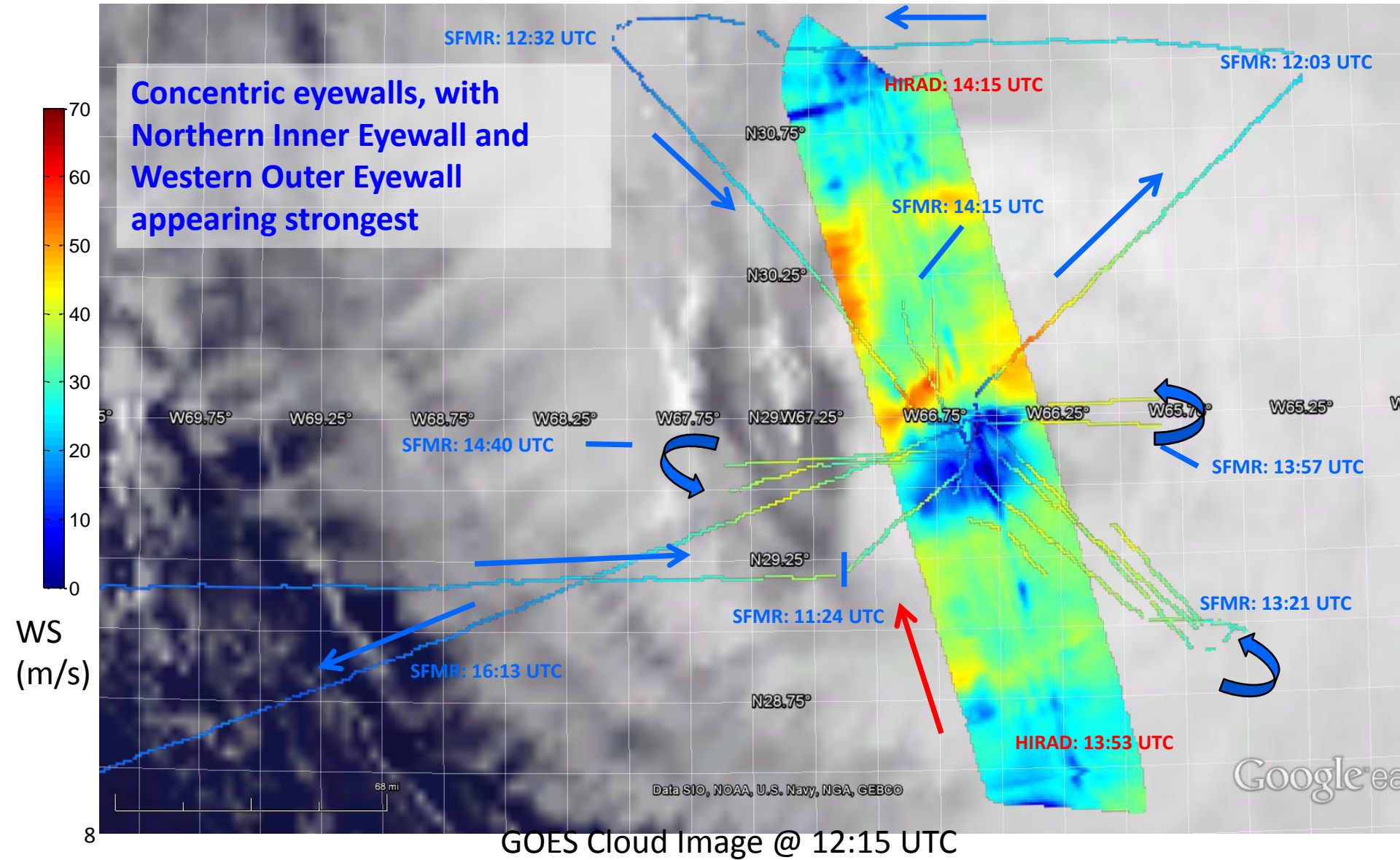


Geophysical model based on El-Nimri et al. (2010), Uhlhorn et al. (2007), Uhlhorn and Black (2003)

Wind Speed Histogram Comparison

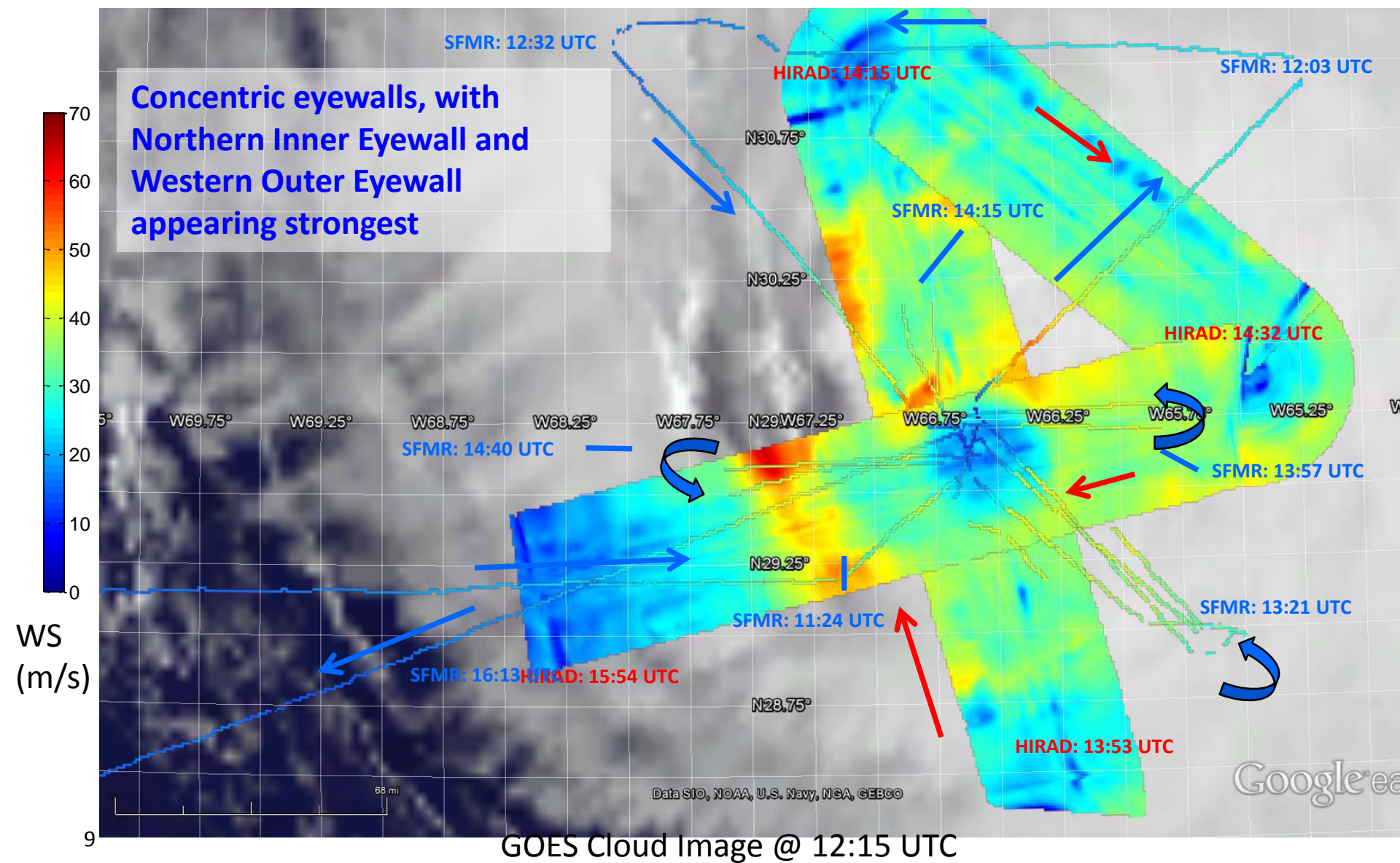


# First Storm Center Crossing: 14:04 UTC



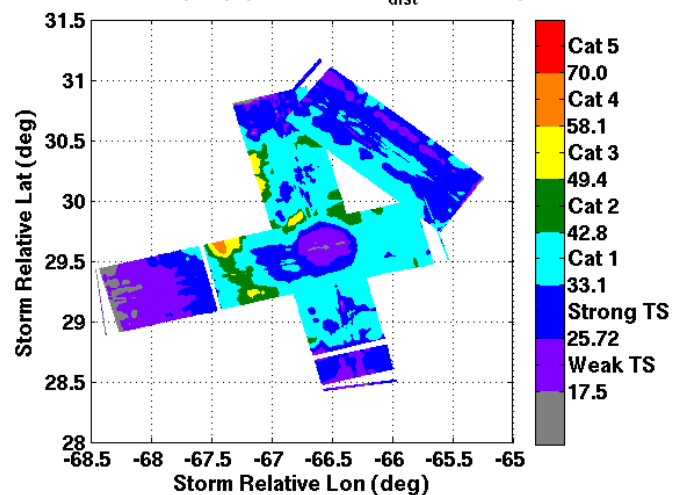


# Second Storm Center Crossing: 14:41 UTC

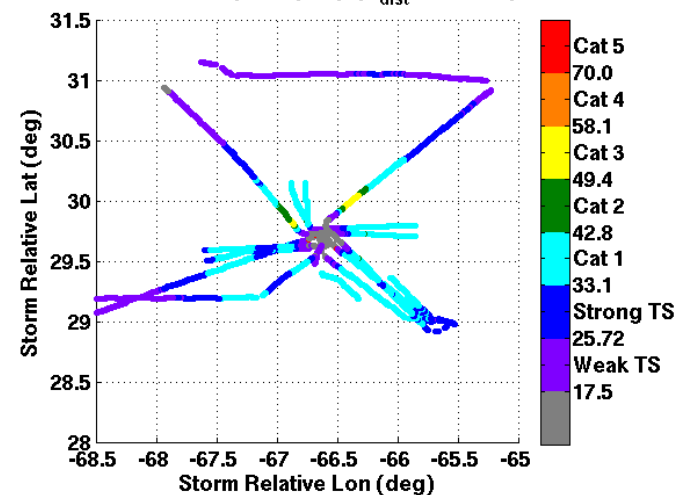


# Wind Retrievals – Oct 17 Gonzalo

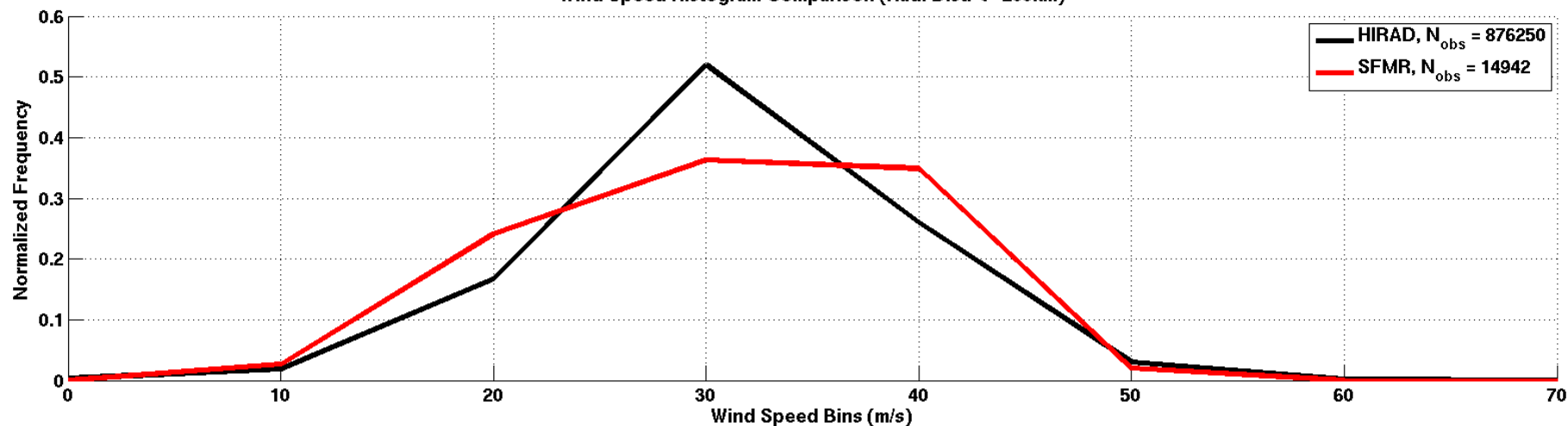
HIRAD WS(m/s), (Roll  $< \pm 1^\circ$ ,  $R_{\text{dist}} \leq 200\text{km}$ )



SFMR Wind Speed (m/s), ( $R_{\text{dist}} \leq 200\text{km}$ )

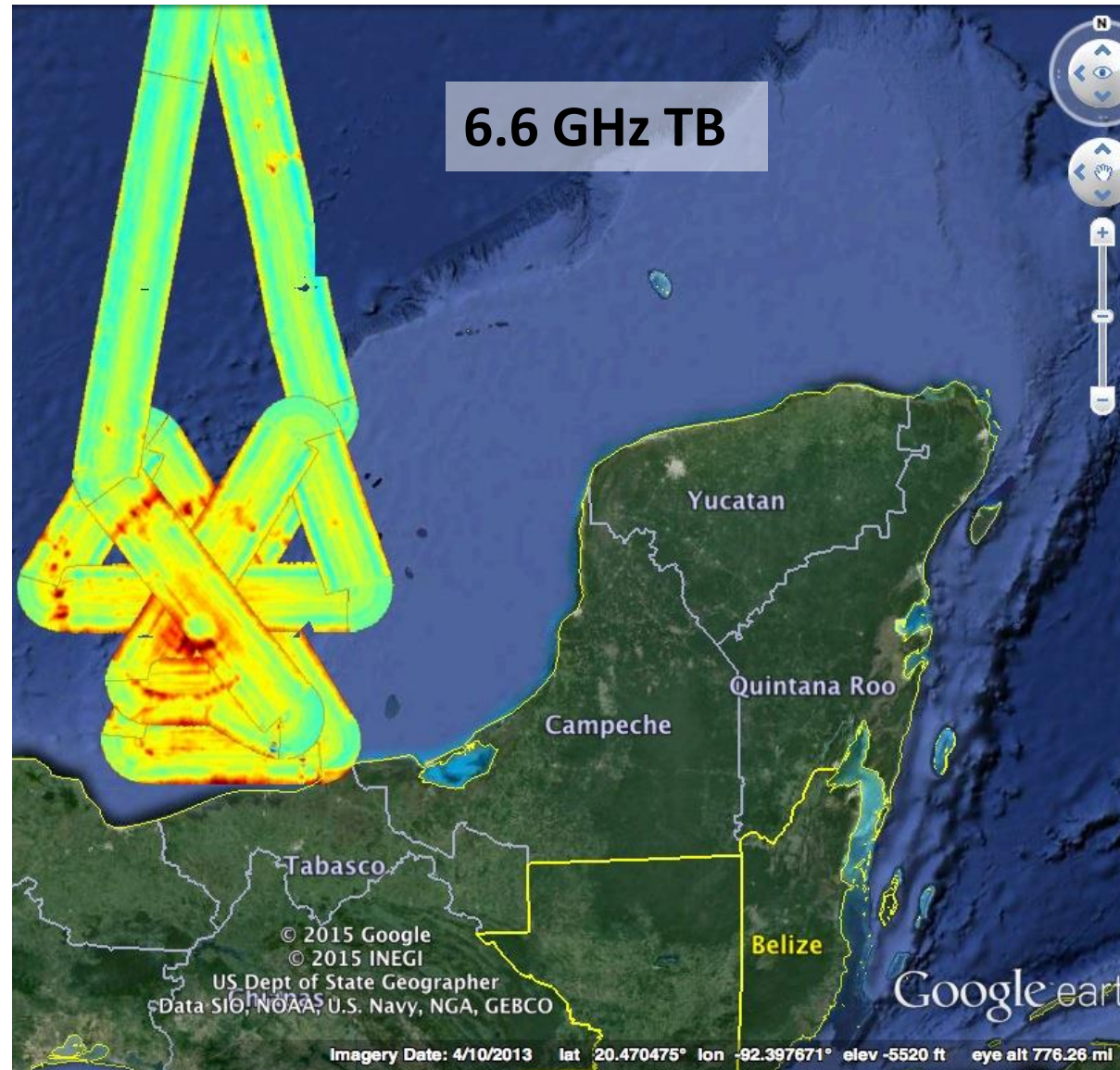
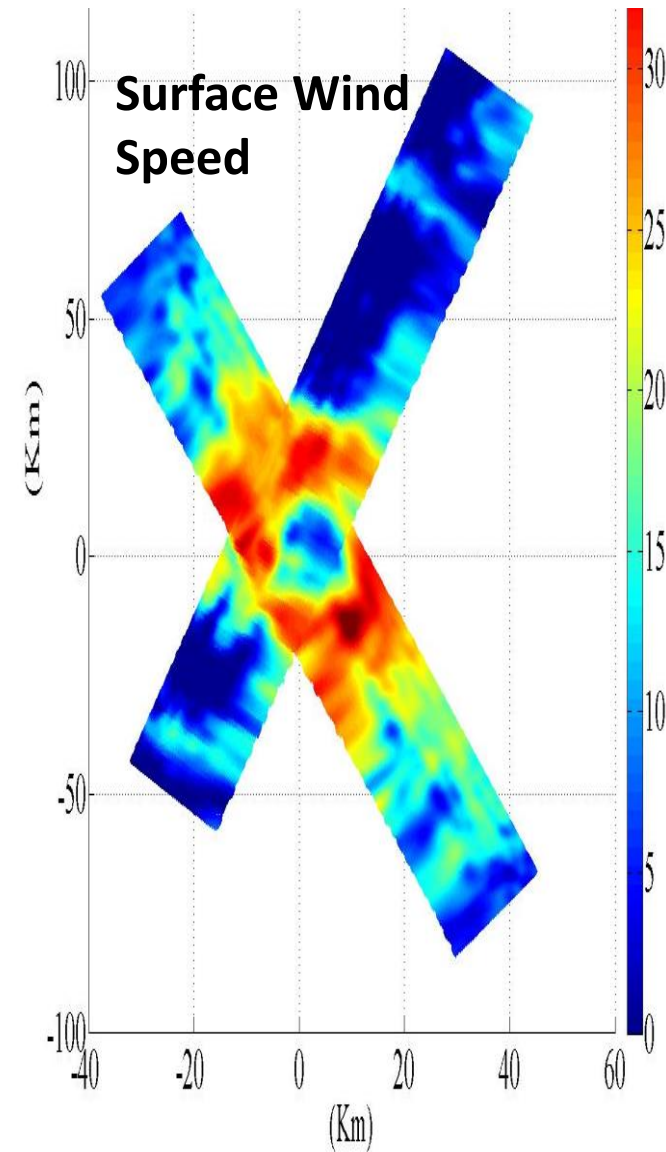


Wind Speed Histogram Comparison (Rad. Dist.  $\leq 200\text{km}$ )





# Hurricane Karl (2010) Brightness Temp and Wind Speed Retrieval





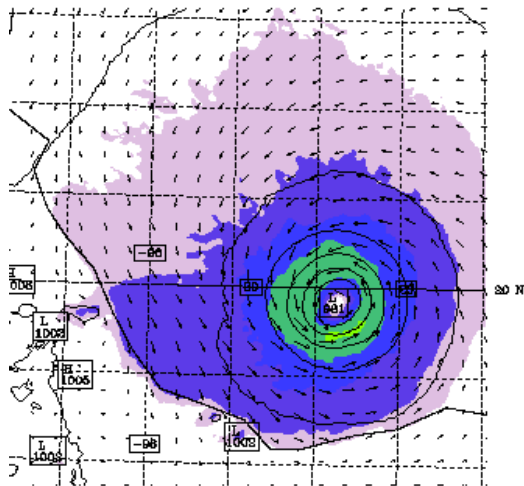
# HIRAD Wind Retrieval, Assimilation for Hurricane Karl

Surface wind field in data assimilation experiments from Jason Sippel at GSFC

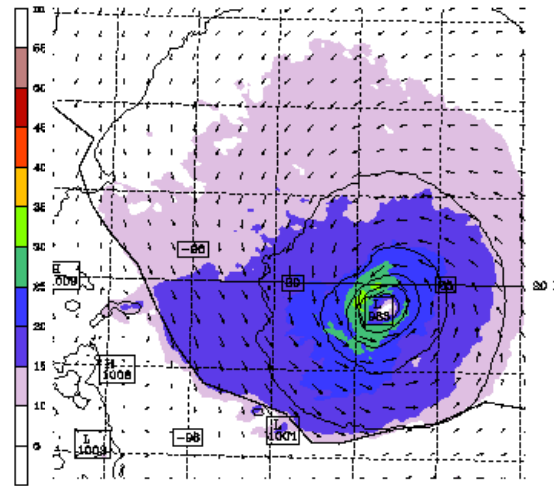
Adding HIRAD (bottom middle) improves characterization of asymmetric nature of wind field, and correctly reduces the horizontal extent of the wind field. Control and Control+HIWRAP(radar) experiments had Radii of 50-kt and 34-kt winds too large, compared to Best Track

Best results from assimilating Dropsonde, HIRAD, HIWRAP together

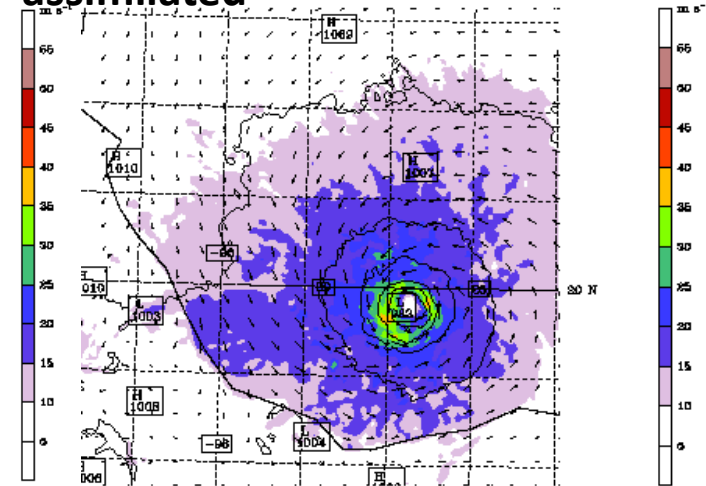
**HIWRAP VAD wind assimilated**



**HIRAD surface wind and HIWRAP VAD wind assimilated**



**HIRAD surface wind, dropsonde wind, and HIWRAP VAD wind assimilated**



# Summary

- 3 Science Flights from WB-57 over Hurricane Gonzalo (2014)
- Wide-swath data helps paint a picture of hurricane structure
- Initial retrievals from Oct 15, Oct 17 flights look good, some systematic (scan-angle dependent) biases remaining
- Oct 16 data needs more cleanup before retrievals, but hurricane structure is there
- Hurricane Karl (2010) wind retrievals tested in assimilation with dropsondes and HIWRAP; improved structure of wind radii

